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Compensation of Pulse-Rebalanced Inertial Instruments

A study has been carried out to formulate a sound theoretical basis for designing and evaluating pulse-rebalanced instruments (and the associated compensating networks), such as pulse-rebalanced integrating accelerometers and gyroscopes with periodic error sampling. A particular difficulty in the design of such instruments is the analysis of nonlinear instabilities in the rebalance loop. A further complication is the use of sampling introduced primarily because the precise control of pulse width to maintain a stable torque scale factor requires that the detection and switching be synchronized with a crystal clock.

The basic concepts of pulse-rebalanced inertial instruments are explained in terms of an idealized model which performs the processes of integration, prediction, and quantization. The ideal quantizer contains a step discontinuity and a periodic sampler with feedback through a zero-order hold and an integrator. The quantizer may follow binary or ternary switching laws.

An analytical model of an actual pulse-rebalanced instrument was derived in a form comparable to the idealized system. A novel approach was used to provide criteria for designing a cascade filter to ensure linear

separation of signal and noise. The combination of a linear ramp function (over a short time interval) and the cascade filter is parallel-compensated to achieve ideal quantizer characteristics. An analytical example is outlined, suggesting a possible application of the theory, using simple circuitry, to compensate a pulsed, inertial reference integrating gyroscope developed by the M.I.T. Instrumentation Laboratory.

Note:

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